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Understanding stakeholder attitudes to CCS in Victoria, Australia

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Abstract

This research was designed to understand how Victorian residents perceive and accept potential carbon capture and storage (CCS) projects. In total twelve focus group sessions were conducted across Bairnsdale, Traralgon and Melbourne, Victoria. The results demonstrate there is limited awareness of the technology and a need for information and education on CCS. A proportion of the respondents (more than 32%) had questions of a “technical” nature, suggesting that participants sought additional information while considering their acceptance of CCS technology. The findings suggest that support for CCS is positively influenced by subjective norms, and trust in the information source delivering the message. Many of the participants welcomed the opportunity to be engaged on the topic and provided a number of suggestions on how best to engage the Victorian public on the topic of CCS and energy technologies more broadly.

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1. Introduction

Brown coal is the primary energy source (85%) for electricity generation in Victoria and one of the largest contributors to Australia’s total domestic greenhouse gas emissions [1]. The remainder of Victoria’s supply is natural gas and renewable energy sources including hydro-electricity, wind and solar. Low emission energy technologies have the potential to reduce greenhouse gas emissions in the state substantially over the coming

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decades. Carbon Capture and Storage (CCS) is one such technology that has been identified as being able to capture large amounts of CO₂, both from electrical power generation and other industrial processes, and store it underground. However, as a new and emerging technology, CCS is not well understood by many, particularly the general public [2]. As CCS has a number of uncertainties associated with it, public acceptance has been identified as a critical success factor for the ongoing deployment of CCS [3].

Recognising this, the Victorian Government's former Department of Primary Industries (DPI) along with the Global CCS Institute commissioned the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to undertake research to understand how Victorian residents perceive and accept potential CCS projects. The objectives of the research were to:

- Identify current knowledge levels and attitudes towards climate change and low emission energy technologies with a specific focus on CCS
- Identify issues and concerns raised and the information gaps that may exist about the understanding of these technologies with a specific focus on CCS
- Evaluate the impacts of information provision on existing opinions of the lay public
- Determine how best to engage the public about CCS projects in Victoria in order to inform the development and enhancement of community engagement and communications strategies and tools.

1.1. Methodology

Focus group participants were recruited from the general public within three study areas in both regional and metropolitan Victoria in May 2012. A total of 12 focus group sessions were conducted across Bairnsdale (population 11,820), Traralgon (population 23,835) and Melbourne (population 4.35 million)[4]. These three locations were selected either because of their proximity to brown coal power stations and therefore increased likelihood of being impacted by CCS, or being the capital city of the state – to compare and contrast suburban views with regional ones. In each location, on average, two groups of ten individuals aged 18-35 years old, and two groups of ten individuals aged 36-65 years old were recruited to participate in the study. The age breakdowns were selected by the DPI to represent a cross section of the community with an original cut-off age of 60, which was subsequently extended to 65 to increase participation in the regional areas.

A market research company was contracted to recruit participants for the focus groups. In the metropolitan area of Melbourne, participants were recruited via calling the contacts available in the company's database. In the hard-to-access areas of Bairnsdale and Traralgon, the company used multiple methods of recruitment including various mediums to reach people. Despite increased efforts, males' attendance at the focus groups was lower than expected due to the lower population numbers in those areas. Each participant was offered a \$100 gift voucher for his or her participation in the focus groups.

Each focus group was scheduled to run for two hours and ten minutes. After the initial welcome, participants were asked about their reactions to climate change, their understanding of Victoria's electricity supply and their existing knowledge of CCS. Next, three forms of information on CCS were presented. The first was information from a scientific expert, who has been working in the energy domain for his entire career. The scientific expert provided an overview of climate change and the portfolio of energy options for transitioning to a low carbon energy supply. Second, a short video, the "Carbon Capture and Storage Movie" sourced from Geosciences Australia[†], was shown. And finally, a fact sheet, developed by World Wildlife Fund for Nature (WWF) and the Construction, Forestry, Mining and Energy Union (CFMEU) entitled "The Power to Change: Carbon Capture and Storage (CCS)" was shared.

After the presentation of each piece of information, participants were asked to express their immediate reactions via an electronic voting system. At the end of the information sharing sessions, participants were invited to further discuss their reactions to CCS and how best to engage the Victorian public on the topic. In addition to electronic

[†] <http://www.ga.gov.au/ghg/carbon-capture-and-storage-movie.html>

voting, participants were asked to complete a short questionnaire at the beginning and end of the focus group. In addition to demographics, the pre-workshop questionnaire included items that focused on knowledge of climate change and energy technologies and understanding of CCS; attitudes towards climate change and energy technologies; belief in climate change; environmental outlook; and trust in information sources. The post-workshop questionnaire repeated a number of knowledge and attitudinal measures; it also included factors influencing support for energy technologies, including subjective norms; perceived impacts of CCS; potential acceptance of CCS and wind projects for a comparison; preferred methods of engagement and levels of trust in workshop components (Copies of surveys available on request to authors). All focus group discussions were audio recorded and transcribed for accuracy.

1.2. Demographics

In total, 108 participants attended the focus groups. Table 1 displays the gender split of 31% male and 69% female participation. As discussed, recruitment of male participants was challenging, resulting in a skewed gender balance. Adults aged 18 to 69 years old were sought for participation and there was a reasonable spread of age groups across all of the focus groups.

Table 1 Participant gender by focus group location

Location	Males (Freq)	Males (%)	Females (Freq)	Females (%)
Bairnsdale	8	21.6	29	78.4
Traralgon	10	27.8	26	72.2
Melbourne	15	42.9	20	57.1

Participants' highest level of education achieved varied considerably, with 22% having completed up to Year 12 or equivalent and 47% having had some level of high school education. Eight percent (8%) had completed either a trade certificate or apprenticeship. Similarly, 8% indicated they had a postgraduate degree, with a further 22% achieving a bachelors or honours degree and 14% a diploma.

During the focus group welcome and introductions, participants identified themselves as working in a range of professions including tutors, teachers and coaches; retail and food service professionals; tradespersons; consultants and business owners; human resources and administrative professionals; and artists, actors and designers. Others identified themselves as students and researchers. Some said they were not working and several described themselves as stay-at-home parents or homemakers.

2. Results

2.1. Belief, knowledge and support for climate change and energy technologies

Although some researchers have suggested alternative framing of CCS is important [5], previous research has shown that discussions of CCS are enhanced if framed around climate change and the portfolio of energy options [6,7]. Essentially, without a need to mitigate climate change the need for CCS becomes obsolete. Accordingly, participants were asked a series of questions around climate change to ascertain their current thinking about this topic.

Questions focused around participants' belief in climate change, the causes of climate change and what they think the response to climate change will be. In response to the question "Do you believe the climate is changing now or will change in the next thirty years?" the majority (85%) of participants responded yes, it is already happening. One participant indicated they did not believe it was happening, and 7% either felt climate change will start happening in the next 30 years or did not know and were unsure. Similarly, the majority (71%) of participants indicated they felt climate change was caused by both human activities and natural changes in the environment. When asked to indicate

whether they felt Australia should take action to respond to either current or future climate change, participants overwhelmingly indicated a positive response (94%).

It is recognised that knowledge, including self-rated knowledge, impacts on an individual's attitude towards a technology [8]. As such, focus group participants were asked to rate their knowledge of a range of energy sources/technologies on a scale of 1=no knowledge through to 7=high knowledge. (The pre- and post- workshop means are reported in brackets for each technology). Not surprisingly, participants reported higher knowledge of more traditional energy technologies such as solar (3.91; 4.56), coal (3.56; 4.55) and wind (3.34; 4.21) and rated their knowledge of CCS (2.19; 5.06) and coal seam gas (2.16; 3.44) the lowest. Echoing similar research processes that include an information provision component, participants' self-rated knowledge increased significantly ($p<0.001$) across all technologies [9] with the greatest reported increase being for CCS, the main topic of the focus groups.

Participants were also asked to rate their level of agreement with the use of the same range of energy sources/technologies as they did for self-rated knowledge on a scale of 1=strongly disagree through to 7=strongly agree (The pre- and post- workshop means are reported in brackets for each technology). Renewable sources such as solar (6.16; 6.00) and wind (5.20; 5.55) received the most support while non-renewable sources received the least. For example, nuclear (3.05; 3.50) and oil (3.68; 3.95) had the lowest support. Support for CCS (4.08; 5.48) increased the most of all the energy sources/technologies presented, reflecting a positive response to the focus group process and information provided.

2.2. Focus on CCS

Throughout the focus group sessions, participants had the opportunity to ask the scientific expert questions about CCS and the context in which it may operate. Occasionally they followed lines of questioning which led into broader topics and areas connected to CCS, such as the carbon price and other motives and incentives for mitigating climate change. Analysis of all 156 questions from participants, across all focus groups in relation to CCS were considered to represent six key themes which included:

1. CCS impacts and CO₂ behaviour underground (32%)
2. Alternatives and comparisons between CCS and other technologies/options (22%)
3. Economics of CCS and the Australian carbon price (17%)
4. Current events in relation to CCS and international comparisons (17%)
5. Ulterior motives and vested interests supporting CCS (6%)
6. Timelines for deployment and future use of CCS (5%)

A similar pattern of questions was asked in each location, with only a few exceptions. For example, Bairnsdale participants did not raise any questions about when CCS is expected to be widely used. Instead, they were more focused on the economic viability of CCS and the carbon price. In contrast, Melbourne and Traralgon participants had more questions about how CCS works, how CO₂ behaves, its properties, and what potential consequences might result from CCS.

2.3. Perceived impacts of CCS

In response to the question on what they felt would be the environmental impacts of CCS, a series of open-ended comments were provided. A considerable number of participants (31.4%) thought CCS will improve the environment and/or lower emissions, however there was a reasonable degree of risk consciousness shown by some (17.5%), reflecting a recognition that the effects of CCS (including the long-term) are uncertain and could be negative. Similarly, participants were asked to identify what they thought might be the impacts of CCS on people and wider society. Many participants were neutral in their response. However, the most commonly reported impacts were more, different or better protected jobs (15.4%), followed by increased costs and taxes to the community (13.8%).

3. Factors associated with support for CCS

3.1. Attitudes to CCS post focus groups

A hierarchical regression analysis investigating the overall acceptance of CCS technology after completion of the focus groups was undertaken. In the first step, the demographic variables, age and gender, were included. The results are presented in Table 2 and show that age and gender did not increase the amount of variance explained in attitudes towards CCS as an emission reduction technology ($R^2=0.01$, Adj. $R^2=0.03$, $F(2, 104)=1.66$, *ns*).

Step 2 included participants' attitudes and knowledge about CCS, participants' beliefs about climate change and participants' trust in CSIRO before the start of the focus group. Results show that belief in climate change (-0.20 , $p<0.05$) was the only variable able to significantly contribute to the explanation of the variance in attitudes towards CCS. Combined, the variables in the model explained 9% of the variance in attitudes towards CCS ($R^2=0.15$, Adj. $R^2=0.09$, $F(6, 95)=2.74$, $p<0.05$).

Step 3 included the participants' reported knowledge and attitudes towards CCS, participants' beliefs about climate change, participants' reflection of the approval of friends and family, and trust in the scientific expert that delivered the focus group presentation. Results indicate that participants that had a high level of trust in the focus group presenter (0.30 , $p<0.01$), and the belief that people who are important to them will agree with their position towards the use of low emission fuel based energy (0.22 , $p<0.05$) contributed significantly to the explanation of the variance in attitudes towards CCS ($R^2=0.49$, Adj. $R^2=0.43$, $F(10, 89)=8.46$, $p<0.001$). Taken together, the variables in the model explain 43% of the variance in post-focus group attitudes towards the use of CCS as an energy technology. In summary, taking into consideration all variables in the model, support for CCS after the focus group was:

- Negatively influenced by participants' beliefs towards climate change prior to the focus group, meaning that participants with stronger belief that climate change was happening prior to the focus group were less likely to support CCS
- Positively influenced by subjective norms, meaning that participants who believed that their support for CCS would be approved by family and friends were more likely to support CCS
- Positively influenced by trust in the information source, meaning that participants who placed a higher level of trust in the focus group presenter were more likely to support CCS.

Table 2 Regression results for attitudes towards CCS after focus group attendance

Attitudes to CCS post workshop	Unstandardised Coefficients	Beta	Standard Error	T-Value	P-Value
Step 1	$F(2, 104) = 1.66$ $R^2 = 0.03$ Adj. $R^2 = 0.01$				
Age	0.009	0.104	0.008	1.20	0.234
Gender	-0.271	-0.104	0.208	-1.31	0.194
Step 2	$F(6, 95) = 2.74^*$ $R^2 = 0.15$ Adj. $R^2 = 0.09$ $\Delta R^2 = 0.11^*$				
CCS attitudes pre-questionnaire	-0.086	-0.065	0.107	-0.80	0.425
Knowledge CCS pre-questionnaire	-0.037	-0.036	0.090	-0.41	0.686
Attitudes towards climate change pre-questionnaire*	-0.037	-0.199	0.019	-1.99	0.049
Trust in CSIRO	0.175	0.127	0.119	1.46	0.147
Step 3	$F(10, 89) = 8.46^{***}$ $R^2 = 0.49$ Adj. $R^2 = 0.43$ $\Delta R^2 = 0.34^{***}$				
Knowledge CCS post-questionnaire	0.157	0.164	0.086	1.82	0.072
Attitudes towards climate change post-questionnaire	0.038	0.198	0.022	1.72	0.088
Attitude of others regarding support for	0.208	0.218	0.086	2.43	0.017

low emission fossil fuel based energy*

Trust in expert**	0.302	0.304	0.106	2.85	0.005
Constant	1.520		0.917	1.66	0.101

***Statistically significant at $p < 0.001$

** Statistically significant at $p < 0.01$

*Statistically significant at $p < 0.05$

3.2. Difference in attitudes towards CCS due to focus group attendance

In order to investigate the impact of the focus group on participants' attitudes towards CCS, a hierarchical regression analysis was performed. In the first step, the demographic variables, age and gender, were included. The results are presented in Table 3 and show that age and gender did not contribute to the explanation of the variance in changes in attitudes towards CCS ($R^2=0.01$, Adj. $R^2=0.03$, $F(2, 104)=1.66$, *ns*).

Step 2 included participants' trust in CSIRO before the start of the focus group. Results show that trust in CSIRO did not significantly contribute to the model, but taken together, the variables explained 5% of the variance in changes in attitudes towards CCS ($R^2=0.08$, Adj. $R^2=0.05$, $F(3, 100)=2.94$, $p < 0.05$).

Step 3 included changes in participants' knowledge and attitudes towards CCS, change in participants' beliefs about climate change, participants' reflection of the approval of friends and family, and trust in the scientific expert that delivered the focus group presentation. Results indicate that participants' changes in attitudes (0.22, $p < 0.05$) and the belief that people who are important to them will agree with their position towards the use of low emission fossil fuel based energy (0.28, $p < 0.001$) contributed significantly to the explanation of the variance in changes in attitudes towards CCS ($R^2=0.32$, Adj. $R^2=0.27$, $F(7, 92)=6.20$, $p < 0.001$). Taken together, the variables in the model explain 27% of the variance in changes in attitudes towards the use of CCS as a result of attending the focus group. In summary, taking into consideration all variables in the model, changes in attitudes towards CCS due to participation in the focus group were:

- Positively influenced by an increase in participants' beliefs towards climate change, meaning that participants who increased their climate change beliefs as a result of participating in the focus group were more likely to increase their support for CCS
- Positively influenced by subjective norms, meaning that participants who believed that their support for CCS would be approved by family and friends were more likely to increase their support for CCS.

Table 3 Regression results for changes in attitudes towards CCS due to focus group attendance

Attitudes to CCS post workshop	Unstandardised Coefficients	Beta	Standard Error	T-Value	P-Value
Step 1	$F(2, 101) = 1.67$ $R^2 = 0.03$ Adj. $R^2 = 0.01$				
Age	0.013	0.110	0.011	1.13	0.260
Gender	-0.006	-0.002	0.298	-0.02	0.985
Step 2	$F(3, 100) = 2.94^*$ $R^2 = 0.08$ Adj. $R^2 = 0.05$ $\Delta R^2 = 0.05^*$				
Trust in CSIRO	0.162	0.090	0.173	0.94	0.350
Step 3	$F(7, 92) = 6.20^{***}$ $R^2 = 0.32$ Adj. $R^2 = 0.27$ $\Delta R^2 = 0.24^{***}$				
Difference in knowledge	0.177	0.165	0.106	1.67	0.098
Difference in climate change attitudes*	0.060	0.216	0.026	2.33	0.022
Attitude of others regarding support for low emission fossil fuel based energy**	0.345	0.277	0.124	2.79	0.006
Trust in expert	0.131	0.100	0.149	0.88	0.383
Constant	-3.046		0.973	-3.13	0.002

***Statistically significant at $p < 0.001$

** Statistically significant at $p < 0.01$

*Statistically significant at $p < 0.05$

4. Discussion

4.1. Issues, concerns and information gaps

Within the regional workshops, coal and the local power stations, were seen as integral to the local community's economy. Participants in Melbourne held a somewhat different view about their importance but were similarly aware that coal was a key provider of Victoria's energy. Some participants in Bairnsdale and Traralgon vividly recalled the negative impact of the privatisation of Victoria Energy on their livelihoods through the downsizing and retrenchments that had occurred at the time. These reactions meant that initially some participants in the regional focus groups were positively disposed to the concept of CCS as it appeared to present an opportunity to prolong a fundamental industry for their local economy.

However, there were a range of issues and concerns that were raised through participant questions. Many of these related to the safety of CCS and potential environmental risks that might arise from the process – either through unexpected leaks back into the atmosphere or through contamination into fresh water. The likelihood of contamination with water was discussed in relation to the area being seen as an important food producing area.

Another issue was the need for CCS to be placed in context with other options such as renewable energy technologies. More specifically, participants were interested to find out more about comparisons and evaluations that had been carried out to justify the decision to invest and develop CCS as opposed to other potential climate mitigation technologies. There was a clear message from all workshops that participants did not want to see CCS technology developed at the expense of renewable energy and they were keen to see ongoing investment in development of the renewable energy industry.

The other major issues raised were around the cost of CCS, the size of investment required and connection to the carbon price. Participants saw the need for a price to bring about action on climate change but were worried about the flow-on impacts to them - recognising the high emissions generated from coal might eventually lead to local power stations being closed. Similarly, because they had already experienced increased electricity prices they were concerned about what the final cost of electricity generation might be with the move towards a low carbon energy supply.

4.2. Impacts of information provision on existing opinions

Before the focus groups, participants' beliefs and attitudes towards climate change were not related to their attitudes towards the use of CCS as an energy technology. Results indicate that prior to the focus groups, participants might not have considered CCS as a potential low emission energy technology that could contribute to climate change mitigation. As a result of the information provided in the focus groups, participants rated their knowledge as higher on a host of climate and energy related issues, including CCS. Increased support for the use of CCS as an energy source by participants was affected by an increased belief that climate change is an important issue to Australia and more should be done to reduce greenhouse gas emissions. This is in line with previous research that has shown that discussions of CCS are enhanced if framed around a portfolio of energy options [10].

In the regression analysis, participants' trust in the scientific expert was shown to be an important factor for informing their positive opinions and appeared to positively impact on their attitudes towards CCS. Participants appreciated the opportunity to engage with the scientific expert so that they could have their questions answered and seek further clarification about any issues that arose as a result of hearing the information.

Participants also commented they found the video format useful in providing an overview of how the technology process might work. However, concerns were expressed around the positioning of the fact sheet, in that it was seen to be overly positive and advocating for CCS technology rather than presenting an objective view. In almost all of the workshops, the discussion that followed the presentation of the fact sheet was around vested interests and how this made them sceptical of the information and 'switch off'. One participant even stated, "after the first part I just stopped reading". The facilitator also observed this response to the fact sheet. This demonstrates the importance of finding objective information about the topic if it is to maintain credibility with the public or other stakeholders.

4.3. Ideas for engaging the public on CCS

The focus group discussions suggested a need for more information and engagement about CCS, particularly having more technical information available in easily understood and accessible formats. However, participants cautioned that too much information can be overwhelming and confusing so it would be important to simplify the amount of information provided so as not to overload the end user. Through the discussions, participants also acknowledged that people would learn from and respond to information in different ways and therefore communication efforts would need to be targeted towards specific groups.

This idea of targeting specific groups was further illustrated by the range of personal preferences described during the focus groups. Some preferred television, either through programming or advertising, as an effective way to inform them of new information. These participants responded positively to the video as a useful way to inform the masses. Others however said they would be more likely to read information that was made available on the Internet or in the newspaper. Participants felt face-to-face communication, similar to what they experienced in the focus group was also useful as they were able to ask an expert their specific questions. They were also appreciative of CSIRO's role in facilitating the workshop as an independent, well-known and respected source of scientific information.

The majority of participants expressed their willingness and interest to be engaged if a new energy project was proposed in their area. In fact, many saw this as a positive opportunity. Although it is worth noting that it is a small sample size and these participants may have attended the workshop because they have an active interest in the topic or wanted to participate in the process, particularly with a paid incentive. Not all participants were confident that the methods of engagement would be just. This is an important consideration for those with an interest in engaging local communities around new projects. Much has been written about fairness and participation in citizen engagement and the importance of transparency in the process that is used to inform and these considerations will be equally important for energy projects [11].

5. Conclusions

The research set out to understand how Victorian residents perceive and accept potential CCS projects through the use of focus groups. Although a small sample size, the results suggest that members of the Victorian public have low levels of knowledge about CCS. However, when presented with information in a variety of formats, they develop their own personal understanding of the technology. These opinions are impacted by the information source and the discussions they are engaged in with peers in response to that information.

In addition, while it is important that the public understands the science about CCS, it is also important to place CCS in context with other energy technologies including renewable energy sources, coal and gas. This ensures that public attitudes towards CCS are formed with an understanding of the tradeoffs involved between the alternative technologies and policy solutions. The results also confirm the importance of information on climate change also being presented, as without a belief in the need for action on climate change, it is hard to justify the large investments required to transition to a low carbon energy supply.

Post-focus group attitudes toward CCS were influenced by the high level of trust focus group participants placed in the scientific expert. Future engagement needs to take into consideration that the success of public engagement strategies are highly dependent on the level of trust in the information source, as a range of participants were quick to identify and disregard information they felt was biased. Bringing together information that has been peer reviewed by a diverse range of stakeholders is one way to build that trust. Similarly, those with no vested interest in the outcome can help to ensure credibility in the information.

In terms of engagement strategies, participants were particularly fond of the opportunity to talk in face-to-face environments where they could ask questions. Participants also acknowledged that variety in the processes used was important, that is, there was recognition of the need to develop a range of options to suit a cross section of the population. It was also stressed that the message and information provided needs to be very clear and easy to understand.

Finally, there was an overwhelming interest to be engaged at the local level, yet there seems to be some uncertainty about the actual engagement processes used and whether they will be fair or not. Therefore, it will be

important that communities are adequately informed about the engagement processes and the various options for participating so that those who wish to be involved can be engaged.

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